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Directions for conducting a series of science experiments are presented. The experiments concern the study of heat and molecular motion, heat exchange in a mixture, specific heat, heat and size, expansion of liquid, expansion of air, heat of fusion of ice, heat of vaporization of water, light and sound, law of reflection, plane mirror images, regular versus diffuse reflection, refraction, convex lenses, law of inverse squares, dispersion of light, and lines of force. Pertinent questions to guide observations are given for each experiment.

A list of experiments which involve research on the part of the student is included. The student is to look up the meaning of the terms and then devise an experiment to develop his thinking along such lines. The subject-terms to be researched are: a solenoid; a voltaic cell; an electromagnet; a simple series circuit; a simple parallel circuit; and electric meters, voltmeter, and ammeter.

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Organization

6

ED002310

NOVA SCIENCE UNIT 7

Heat and Molecular Motion

A. You will be furnished a glass tube from which the air has been exhausted and which contains a little mercury covered with small bits of colored glass. Heat the mercury until it boils. What does the behavior of the bits of glass indicate may be happening to the molecules of mercury?

To a glass flask attach a U tube containing mercury to act as a pressure gage. Heat the flask with a flame. What change of pressure is indicated by the mercury in the U tube? Since there are no more molecules of air in the flask than before heating, what would account for the change in pressure?

Heat Exchange in a Mixture

A. In a calorimeter, weigh out 300 grams of the coldest water you can get. Heat an equal weight of water to a temperature as far above room temperature as the cold water is below. Stir both well and take accurate temperatures. Mix both in the calorimeter. Read the mixed temperature. Carefully record your observations and interpret them.

Specific Heat

A. Put a 500 gram lead or aluminum block into a boiling water. Weigh out enough cold water to cover the block when it is placed in a calorimeter. When you are sure the block is warmed to 100°C, stir the cold water and measure its temperature; put the block in the calorimeter being sure it is covered by the cold water. Stir well and check the water temperature recording the temperature when the mercury comes to rest. The following will help you in reaching a conclusion.

1. Calories (???) gained by the water = calories lost by the metal.
2. Calories gained by water = grams of water X temperature change X specific heat of water.
3. Calories lost by metal = grams of metal X temperature change X specific heat of metal.
4. Specific heat = ?????????

Heat and Size

A. Obtain from your instructor a ring and ballapparatus and a compound bar. Before using these you'll have to learn what they are. After you've done this devise several experiments with these devices, record your data and reach a conclusion based on your observations.

Expansion of Liquid

A. Fill a test tube with colored water, a second one with colored alcohol and a third with mercury. Fit six inch lengths of glass tubing into one hole stoppers and adjust the stoppers until the liquid stands at the same level in each tube. Mount the test tubes in such a way that all three tubes can be lowered into a container of hot water. Record your data and observations and reach a valid conclusion.

B. If you would like to go further devise a paper scale that can be mounted behind the glass tube. Record the level of the liquid in the glass tube at various temperatures. Plot a graph of liquid height against temperature.

Expansion of Air

A. Insert a straight glass tube into a 1 hole rubber stopper. Clsoe the mouth of a flask with the stopper, invert and put the end of the tube into a container of colored water. Warm the flask with your hands until a few bubbles come up through the water. Allow the flask to cool. What do you observe? Now warm the flask with a burner. Cool the flask by wetting and fanning or with ice. Record all of your observations. Could this be used as a thermometer?

Conductivity of Water

A. By means of a cord of wire, hold a piece of ice at the bottom of a test tube of water. Slant the tube and heat it carefully near the top until the water boils there. The ice does not melt. Why?

Heat of Fusion of Ice

A. Heat some water to about 50^0 and weigh out 300 grams of it in a heat insulated container. Record the temperature and immediately drop into the water a lump of ice as large as an egg. Stir the water until the ice is melted and take the resulting temperature at once. Weigh the mixture and find the weight of the ice. Remember the heat taken up by the ice is given off by the can and the water. Use the following as needed:

Weight of can X specific heat X temperature change = heat given up by the can (S. H of can is taken as 0.1).

Weight of water X temperature change X specific heat+ heat given up by hot water.

Weight of ice X temperature change X specific heat = heat needed to warm ice water to final temperature.

Heat of Vaporization of Water

A. Weigh out 300 g of cold water in an insulated container. Record the temperature of the water and pass steam into the cold water until the temperature has risen 18°-20°. Remove the steam jet, record the temperature of the water and weigh the warmed water and container in order to calculate the amount of steam condensed in the cold water.

Weight of container X specific heat X temperature change = calories absorbed by the container.

Weight of water X specific heat X temperature change = calories absorbed by the water.

Weight of steam X temperature change = calories furnished by steam after condensing.

Light and Sound

Law of Reflection

A. Let a slit of light fall on a mirror. On a piece of paper in front of the mirror trace the incoming slit of light and the reflected slit. Change the position of the mirror and trace several other rays. Determine what a normal is and derive some relationship between the incoming ray, the normal and the reflected ray.

Plane Mirror Images

A. In a darkened room stand a lamp or lighted candle about a foot in front of a verticle pane of glass. Behind the glass move a similiar lamp or candle until it appears to coincide with the image of the first lamp. Turn off the second lamp and see if it did not exactly replace the image of the first lamp in size, position and location.

B. Now stand a small clock or a translucent paper with large letters on it with the back toward you and the face toward the mirror. Record your observations. Push the clock face up to the mirror and look to see if all the parts of the clock fall on the corresponding image part. We use the word "symmetrical" to describe this relationship between object and image.

C. Draw a triangle on a sheet of paper. Stand a small mirror two inches back of the triangle. Stand a pin at each angle in turn and look at the image of the pin in the mirror. From the first eye position sight along the ruler for each pin position. Move over to the second eye position and draw a corresponding sight line toward the mirror. Mark the position of the mirror with a pencil line, remove it and extend the pair of lines until they meet. Repeat for the second and third pin. Compare the image size with the object size.

Regular Vs Diffuse Reflection

A. In a dimly lighted room hold a plane mirror so as to receive light from a flash light or other bright source. The reflected light will go off in one direction and illuminate brightly one spot on the wall. Now substitute a sheet of paper for the mirror. Observations. If you look at the paper do you see the paper or an image of the lamp? Contrast this with the mirror. Is there evidence that light is being scattered in many directions by the paper? What does the fact that the paper is visible to everyone in the room indicated?

Refraction

A. Fill a battery jar with water. Cover the jar with a cardboard in which a slit has been cut. Direct a strong light vertically downward on the slit. The beam of light passing through the slit will not be bent on entering the water. Now move the lamp so that the light strikes the water obliquely. What happens to the beam of light at the surface? Clouding the water with a bit of soap makes the water show up better. Place a plane mirror at the bottom of the jar and observed the effects on the beam.

Glass Prisms as Reflectors

In binoculars and many other devices that help us see better glass prisms are used as reflectors. Obtain a glass prism from your teacher and study this phenomena.

Convex Lenses

A. Obtain an optical bench from your instructor or ready such equipment as you will be furnished.

Case I

Stand in the darkest part of the room and point your instrument at some object more than 100 feet away. Move the lens or the screen until a clear image appears on the screen. Measure the distance from lens to imagine and callthis the focal length of the lens. Record all observations about the image.

Case II

For this and all remaining cases use a candle or a small unfrosted bulb as an object. In case II. Set the lens 6 to 8 focal lengths from the object and focus the image on the screen. Record all observations.

Case III

Reverse the position of the lamp and screen in case II. Record your observatioms and compare them to case II.

Case IV

Set the lamp exactly 2 focal lengths from the lens. Repeat procedures and record your observation.

Case V and VI

Set the lens at 1 focal length or less than 1 from the lamp. Record your observations.

Law of Inverse Squares

Procure a rectangular piece of stiff cardboard a few inches on each edge. On a wall or blackboard. Lay off areas similiar to the rectangle but 1,4,9 and 16 times as large. Place an arc lamp at ehs die of the room opposite the marked-off wall and interpose the cardboard between the lamp and the wall, so that at different distances the shadow of the card will cover the different areas in turn. Measure the distance from the lamp to the wall, and the different distances at which the cardboard was placed to cover with its shadow the area laid. Where is the cardboard when its shadow covers 4 areas as large as itself? When its shadow covers 9 such areas? 16 areas?

Dispersion of Light

Stand a triangle glass prism on one end and let light from the sun or from a light source fall through a narrow slit upon the prism. The light emerges from the prism along a new path and is much spread out. Allow this light to fall upon a white screen, and an image of the slit in all the different colors will appear upon the screen. This color band is called a spectrum. Has the red or the blue been refracted more? What colors can you detect in the spectrum.

Lines of Force

Secure a glass plate and two bar magnets. Sift dry iron filings on the glass, tap the galss gently to aid in the arrangement of the filings. Study several arrangements of the magnets. Record in your notebooks drawings in each case.

Over a magnetic needle and paralled to it place a wire connected to a dry all through a switch. Close the switch and observe the behavior of the needle. Place the wire under the needle and repeat. Reverse the direction of the current and repeat. Record all results and formulate a conclusion.

A. Connect a piece of bare # 18 wire through a switch to a circuit that will send a current of several amperes through the wire. Dip a horizontal section of the wire into a pile of iron filings. Close a switch and raise the wire out of the filings. Result? Open the switch and observe the filings. Is it the attraction of the wire for the filings or the passage of current that causes the filings to group themselves around the wire?

B. Pass the same wire through a horizontal piece of cardboard. Place a small compass near each edge of the cardboard. Close the switch and sprinkle a few iron filings on the card from a shaker. Tap the card lightly. What is the arrangement of the magnetic lines of force surrounding a conductor that carries a current?

The following experiments involve research on the part of the student. You must first look up the meaning of these terms, then devise an experiment to develop your thinking along these lines.

A. A Solenoid

B. A Voltaic All

C. An Electronmagnet

D. A Simple Seric Circuit

E. A Simple Parallet Circuit

F. Electric Meters

(1). Voltmeter

(2). Ammeter